ST

Hardware Manual

- **ST5-Q**
- **ST5-Q-E**
- **ST5-Si**
- **ST5-C**
- **ST10-Q**
- **ST10-Q-E**
- **ST10-Si**
- **ST10-C**

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7/9/10

Applied Motion Products

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Introduction

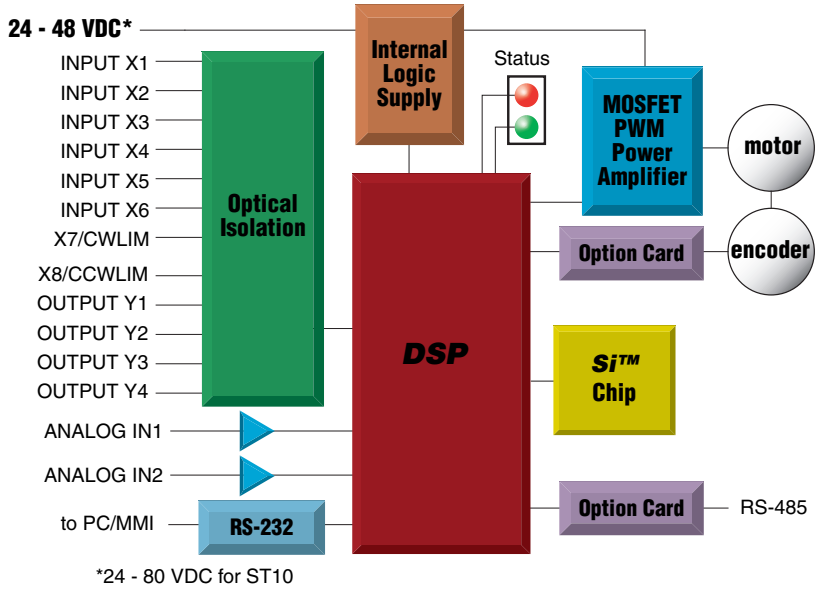
Thank you for selecting an Applied Motion Products motor control. We hope our dedication to performance, quality and economy will make your motion control project successful.

If there's anything we can do to improve our products or help you use them better, please call or fax. We'd like to hear from you. Our phone number is (800) 525-1609, or you can reach us by fax at (831) 761-6544. You can also email support@applied-motion.com.

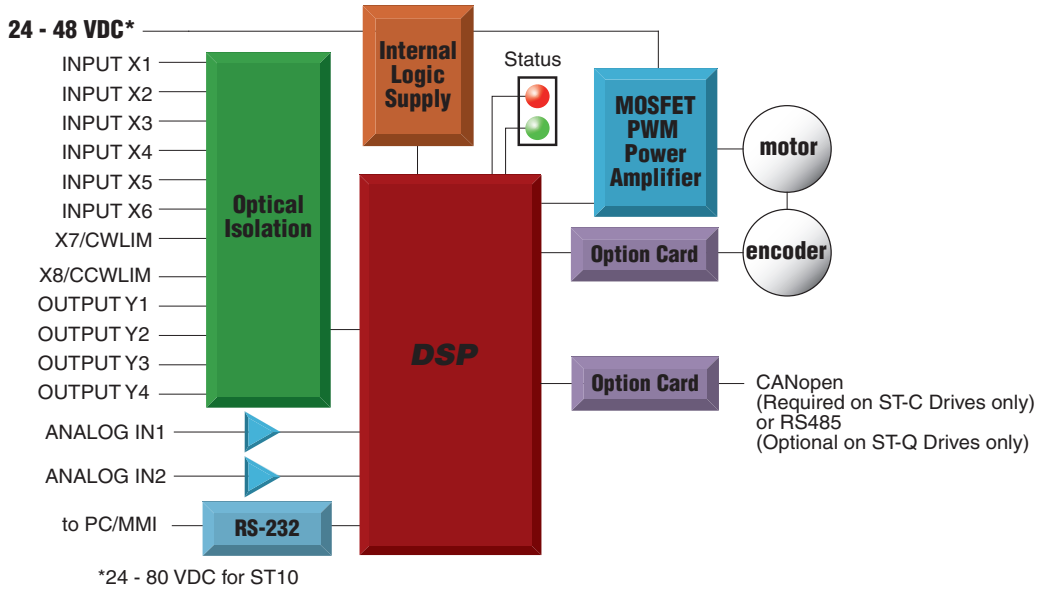
Features

- Programmable, microstepping digital step motor driver in compact package
- ST5 operates from a 24 to 48 volt DC power supply
- ST10 operates from a 24 to 80 volt DC power supply
- Operates in velocity or position mode
- Accepts analog signals, digital signals and RS-232 serial commands
- Optional RS-422/485 communication
- Optional encoder feedback
- Optional CANopen DSP402 Control
- Optional CANopen DS301 communication with DS402 motion control
- Optional 100 Mbit Ethernet communication using SCL and Q
- ST5 provides motor current up to 5 amps/phase (peak of sine)
- ST10 provides motor current up to 10 amps/phase (peak of sine)
- Eight optically isolated digital inputs
- Four optically isolated digital outputs
- Two ±10 volt analog inputs for speed and position control. Can also be configured for 0 to 10V, ±5V or 0 to 5V signal ranges.

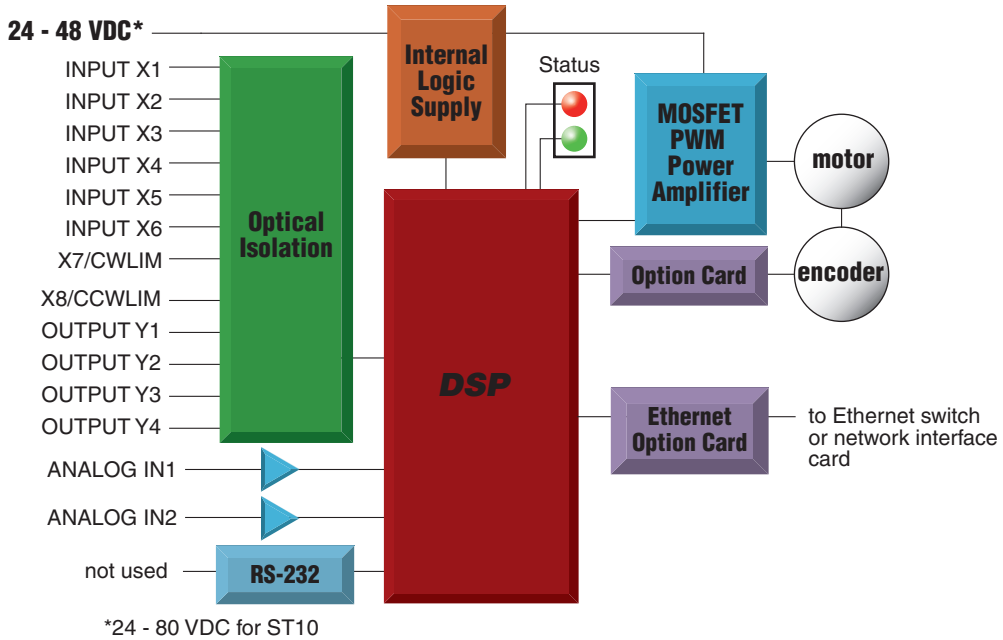
Block Diagrams



ST5-Si and ST10-Si



ST5-Q, ST5-C, ST10-Q and ST10-C



ST5-Q-EN, ST5-Q-EE, ST10-Q-EN, ST10-Q-EE

Getting Started

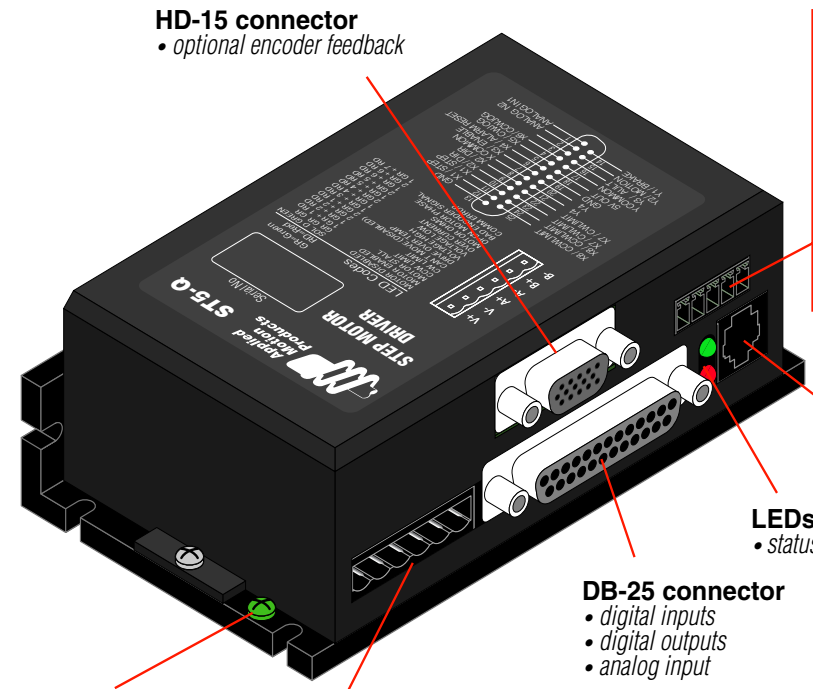
This manual describes the use of six different drive models. What you need to know and what you must have depends on the drive model. For all models, you'll need the following:

- a 24-48 volt DC power supply. (24 - 80VDC for ST10 models). Please read the section entitled *Choosing a Power Supply* for help in choosing the right power supply.
- a compatible step motor. See section on Recommended Motors.
- a small flat blade screwdriver for tightening the connectors (included).
- a personal computer running Microsoft Windows 98, 2000, NT, Me, XP, Vista or 7.
- The Applied Motion CD (included)
- An Applied Motion programming cable (included with non-Ethernet drives).
- For Ethernet drives you will need a CAT5 cable (not included).

If you've never used an ST drive before you'll need to get familiar with the drive and the set up software before you try to deploy the system in your application. We strongly recommend the following:

1. For -S drives, install the *ST Configurator™* software applications from the CD.
   For -Q drives, install the *ST Configurator™* and *Q Programmer™* software applications from the CD.
   For -Q-E drives, install *Ethernet Configurator™* and *Q Programmer™* software applications.
   For -Si models, install and use the *Si Programmer™* software for configuration and programming.
   For -C drives, install the *ST Configurator™* and the *CANopen Example Program* software applications from the CD. *Q Programmer™* software may also be installed, if needed.
2. Launch the software by clicking Start...Programs...Applied Motion...
3. Connect the drive to your PC using the programming cable.
4. Connect the drive to the power supply.
5. Connect the drive to the motor.
6. Apply power to the drive.
7. The software will recognize your drive, display the model and firmware version and be ready for action.

The connectors and other points of interest are illustrated below. Depending on your drive model and application, you'll need to make connections to various parts of the drive. These are detailed later in the manual.



Connecting to the PC using RS-232

• Locate your computer within 8 feet of the drive.

• If you have a CANopen drive, you still need to connect to the RS232 port on your PC to configure the drive, and download Q Programs, if necessary. Once configuration is complete, refer to the CANopen Manual for information on using your CANopen drive.

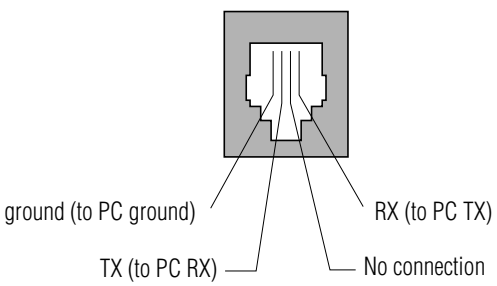
• If you have an Ethernet drive, this port is not used. All communcation uses the RJ45 Ethernet connector.

• Your drive was shipped with a communication cable. Plug the large end into the serial port of your PC and the small end into the PC/MMI jack on your drive. Secure the cable to the PC with the screws on the sides.

Never connect a drive to a telephone circuit. It uses the same connectors and cords as telephones and modems, but the voltages are not compatible.

If your PC does not have a serial port, you should purchase a "USB Serial Converter". We have had good results with the Port Authority "USB Serial DB9" Adapter from CablesToGo.com and with the SW1301 from SewellDirect.com. For 64 bit XP, Vista and Windows 7 systems, the recommended USB serial adapter is USB-COM-CBL from byterunner.com. This adapter also works for 32 bit Windows systems.

For laptops, a PCMCIA converter card is a good choice. Our applications engineers use the SSP-100 from Sewell Direct.



Pin Assignments of the PC/MMI Port
(RJ11 connector)

Connecting the Drive to Your PC using Ethernet

This process requires three steps

- Get the drive physically connected to your network (or directly to the PC)
- Set the drive's IP address
- Set the appropriate networking properties on your PC.

Note: the following pages are an excerpt from the "eSCL Communication Reference Guide". For more information, please read the rest of the guide.

Addresses, Subnets, and Ports

Every device on an Ethernet network must have a unique IP address. In order for two devices to communicate with each other, they must both be connected to the network and they must have IP addresses that are on the same subnet. A subnet is a logical division of a larger network. Members of one subnet are generally not able to communicate with members of another unless they are connected through special network equipment (e.g. router). Subnets are defined by the choices of IP addresses and subnet masks.
If you want to know the IP address and subnet mask of your PC, select Start…All Programs…Accessories…Command Prompt. Then type "ipconfig" and press Enter. You should see something like this:

```
Windows IP Configuration

Ethernet adapter Local Area Connection:

        Connection-specific DNS Suffix  . :
        IP Address. . . . . . . . . . . . : 192.168.0.22
        Subnet Mask . . . . . . . . . . . : 255.255.255.0
        Default Gateway . . . . . . . . . : 192.168.0.254
```

If your PC's subnet mask is set to 255.255.255.0, a common setting known as a Class C subnet mask, then your machine can only talk to another network device whose IP address matches yours in the first three octets. (The numbers between the dots in an IP address are called an octet.) For example, if your PC is on a Class C subnet and has an IP address of 192.168.0.20, it can talk to a device at 192.168.0.40, but not one at 192.168.1.40. If you change your subnet mask to 255.255.0.0 (Class B) you can talk to any device whose first two octets match yours. Be sure to ask your system administrator before doing this. You network may be segmented for a reason.

Your drive includes a 16 position rotary switch for setting its IP address. The factory default address for each switch setting is shown in the table on the next page.

Rotary Switch	IP Address
0	10.10.10.10
1	192.168.1.10
2	192.168.1.20
3	192.168.1.30
4	192.168.0.40
5	192.168.0.50
6	192.168.0.60
7	192.168.0.70
8	192.168.0.80
9	192.168.0.90
A	192.168.0.100
B	192.168.0.110
C	192.168.0.120
D	192.168.0.130
E	192.168.0.140
F	DHCP

Settings 1 through E can be changed using the ST Configurator software (use Quick Tuner for servo drives). Setting 0 is always “10.10.10.10”, the universal recovery address. If someone were to change the other settings and not write it down or tell anyone (I’m not naming names here, but you know who I’m talking about) then you will not be able to communicate with your drive. The only way to “recover” it is to use the universal recovery address.

Setting F is “DHCP”, which commands the drive to get an IP address from a DHCP server on the network. The IP address automatically assigned by the DHCP server may be “dynamic” or “static” depending on how the administrator has configured DHCP. The DHCP setting is reserved for advanced users.

Your PC, or any other device that you use to communicate with the drive, will also have a unique address. When you launch an Applied Motion Ethernet-ready software application, it will display the IP address of your PC on the title bar.

On the drive, switch settings 1 through E use the standard class B subnet mask (i.e. “255.255.0.0”). The

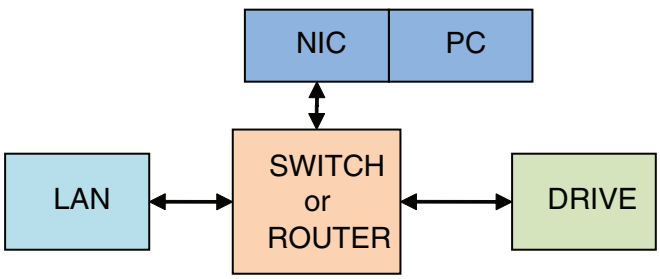
mask for the universal recovery address is the standard class A (i.e. “255.0.0.0”).
One of the great features of Ethernet is the ability for many applications to share the network at the same time. Ports are used to direct traffic to the right application once it gets to the right IP address. The UDP eSCL port in our drives is 7775. To send and receive commands using TCP, use port number 7776. You'll need to know this when you begin to write your own application. You will also need to choose an open (unused) port number for your application. Our drive doesn't care what that is; when the first command is sent to the drive, the drive will make note of the IP address and port number from which it originated and direct any responses there. The drive will also refuse any traffic from other IP addresses that is headed for the eSCL port. The first application to talk to a drive “owns” the drive. This lock is only reset when the drive powers down.

If you need help choosing a port number for your application, you can find a list of commonly used port numbers at http://www.iana.org/assignments/port-numbers.

One final note: Ethernet communication can use one or both of two “transport protocols”: UDP and TCP. eSCL commands can be sent and received using either protocol. UDP is simpler and more efficient than TCP, but TCP is more reliable on large or very busy networks where UDP packets might occasionally be dropped.

Option 1: Connect a Drive to Your Local Area Network

If you have a spare port on a switch or router and if you are able to set your drive to an IP address that is

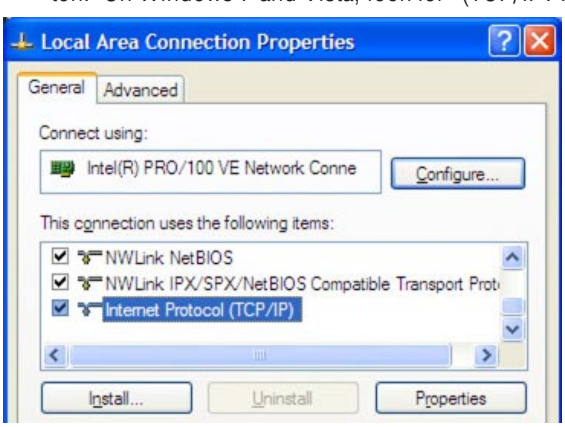


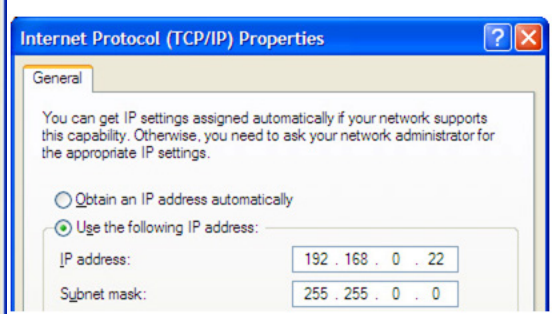
compatible with your network, and not used by anything else, this is a simple way to get connected. This technique also allows you to connect multiple drives to your PC. If you are on a corporate network, please check with your system administrator before connecting anything new to the network. He or she should be able assign you a suitable address and help you get going.

If you are not sure which addresses are already used on your network, you can find out using “Angry IP scanner”, which can be downloaded free from http://www.angryip.org/w/Download. But be careful: an address might appear to be unused because a computer or other device is currently turned off. And many

networks use dynamic addressing where a DHCP server assigns addresses "on demand". The address you choose for your drive might get assigned to something else by the DHCP server at another time.
Once you've chosen an appropriate IP address for your drive, set the rotary switch according the address table above. If none of the default addresses are acceptable for your network, you can enter a new table of IP addresses using *Configurator*. If your network uses addresses starting with 192.168.0, the most common subnet, you will want to choose an address from switch settings 4 through E. Another common subnet is 192.168.1. If your network uses addresses in this range, the compatible default selections are 1, 2 and 3.
If your PC address is not in one of the above private subnets, you will have to change your subnet mask to 255.255.0.0 in order to talk to your drive. To change your subnet mask:

1. On Windows XP, right click on "My Network Places" and select properties. On Windows 7, click Computer. Scroll down the left pane until you see "Network". Right click and select properties. Select "Change adapter settings"
2. You should see an icon for your network interface card (NIC). Right click and select properties.
3. Scroll down until you see "Internet Properties (TCP/IP)". Select this item and click the Properties button. On Windows 7 and Vista, look for "(TCP/IPv4)"




Internet Protocol (TCP/IP) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
192 . 168 . 0 . 22
Subnet mask:
255 . 255 . 0 . 0

4. If the option “Obtain an IP address automatically” is selected, your PC is getting an IP address and a subnet mask from the DHCP server. Please cancel this dialog and proceed to the next section of this manual: “Using DHCP”.
5. If the option “Use the following IP address” is selected, life is good. Change the subnet mask to “255.255.0.0” and click OK.

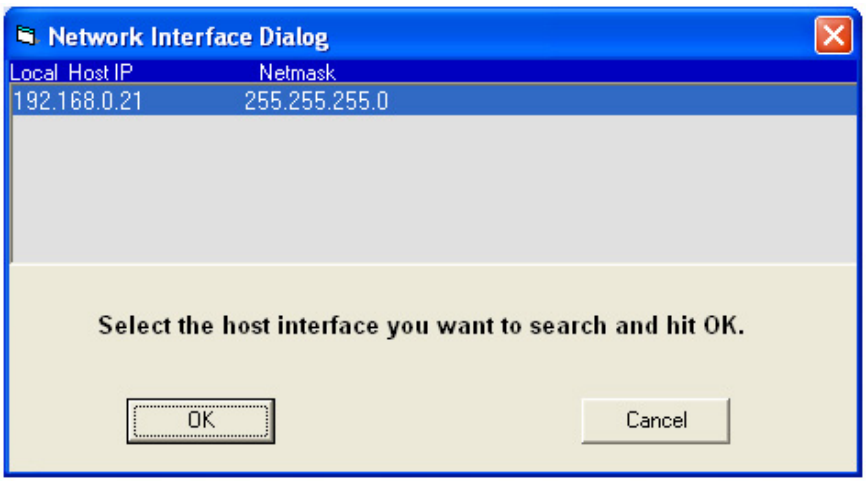
Using DCHP

If you want to use your drive on a network that where all or most of the devices use dynamic IP addresses supplied by a DHCP server, set the rotary switch to “F”. When the drive is connected to the network and powered on, it will obtain an IP address and a subnet mask from the server that is compatible with your PC.

The only catch is that you won’t know what address the server assigns to your drive. Ethernet Configurator can find your drive using the Drive Discovery feature, as long as your network isn’t too large. With the drive connected to the network and powered on, select Drive Discovery from the Drive menu.

You will see a dialog such as this:

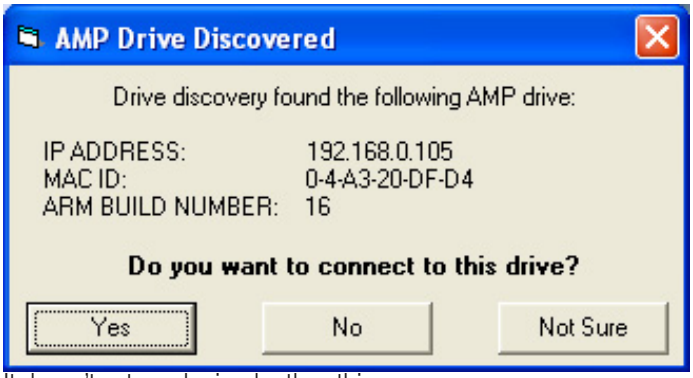
Normally, Drive Discovery will only detect one network interface card (NIC), and will select it automatically. If you are using a laptop and have both wireless and wired network connections, a second NIC may appear.



Please select the NIC that you use to connect to the network to which you’ve connected your drive. Then click OK. Drive Discovery will notify you as soon as it has detected a drive.

If you think this is the correct drive, click Yes. If you’re not sure, click Not Sure and Drive Discovery will look for additional drives on you network. Once you’ve told Drive Discovery which drive is yours, it will automatically enter that drive’s IP address in the IP address text box so that you are ready to communicate.

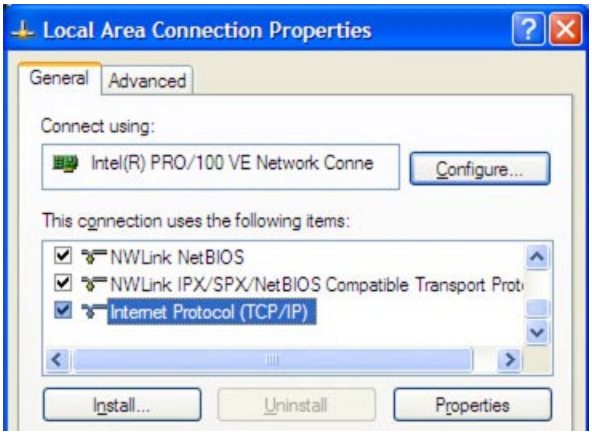
Option 2: Connect a Drive Directly to Your PC



It doesn't get much simpler than this:

1. Connect one end of a CAT5 Ethernet cable into the LAN card (NIC) on your PC and the other into the

drive. You don't need a special "crossover cable"; the drive will automatically detect the direct connection and make the necessary physical layer changes.
2. Set the IP address on the drive to "10.10.10.10" by setting the rotary switch at "0".
3. To set the IP address of your PC:
   a. On Windows XP, right click on "My Network Places" and select properties.
   b. On Windows 7, click Computer. Scroll down the left pane until you see "Network". Right click and select properties. Select "Change adapter settings"
4. You should see an icon for your network interface card (NIC). Right click and select properties.
   a. Scroll down until you see "Internet Properties (TCP/IP)". Select this item and click the Properties



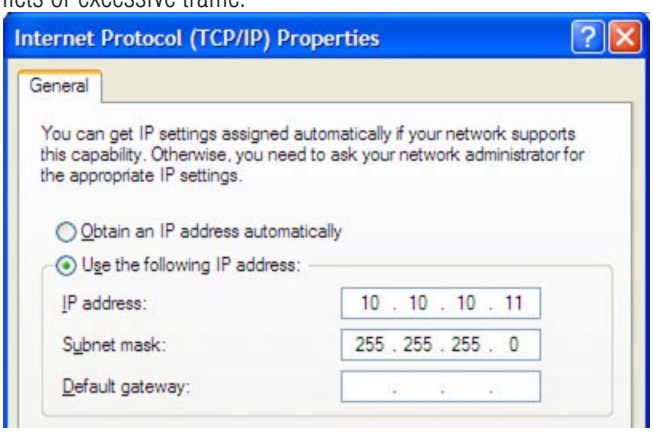
button.

b. On Windows 7 and Vista, look for "(TCP/IPv4)"

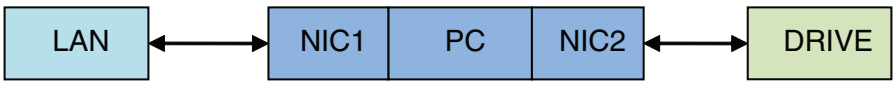
5. Select the option "Use the following IP address". Then enter the address "10.10.10.11". This will give your PC an IP address that is on the same subnet as the drive. Windows will know to direct any traffic intended for the drive's IP address to this interface card.
6. Next, enter the subnet mask as "255.255.255.0".
7. Be sure to leave "Default gateway" blank. This will prevent your PC from looking for a router on this subnet.
8. Because you are connected directly to the drive, anytime the drive is not powered on your PC will annoy you with a small message bubble in the corner of your screen saying "The network cable is unplugged."

Option 3: Use Two Network Interface Cards (NICs)

This technique allows you to keep your PC connected to your LAN, but keeps the drive off the LAN, preventing possible IP conflicts or excessive traffic.

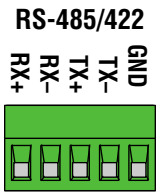

Internet Protocol (TCP/IP) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
10 . 10 . 10 . 11
Subnet mask:
255 . 255 . 255 . 0
Default gateway:

1. If you use a desktop PC and have a spare card slot, install a second NIC and connect it directly to the



   drive using a CAT5 cable. You don't need a special "crossover cable"; the drive will automatically detect the direct connection and make the necessary physical layer changes.
2. If you use a laptop and only connect to your LAN using wireless networking, you can use the built-in RJ45 Ethernet connection as your second NIC.
3. Set the IP address on the drive to "10.10.10.10" by setting the rotary switch at "0".
4. To set the IP address of the second NIC:
   a. On Windows XP, right click on "My Network Places" and select properties.
   b. On Windows 7, click Computer. Scroll down the left pane until you see "Network". Right click and select properties. Select "Change adapter settings"
5. You should see an icon for your newly instated NIC. Right click again and select properties.
   a. Scroll down until you see "Internet Properties (TCP/IP)". Select this item and click the Properties button.
   b. On Windows 7 and Vista, look for "(TCP/IPv4)"
6. Select the option "Use the following IP address". Then enter the address "10.10.10.11". This will give your PC an IP address that is on the same subnet as the drive. Windows will know to direct any traffic intended for the drive's IP address to this interface card.
7. Next, enter the subnet mask as "255.255.255.0". Be sure to leave "Default gateway" blank. This will prevent your PC from looking for a router on this subnet.
8. Because you are connected directly to the drive, anytime the drive is not powered on your PC will annoy you with a small message bubble in the corner of your screen saying "The network cable is unplugged."

Connecting to a host using RS-485 option card



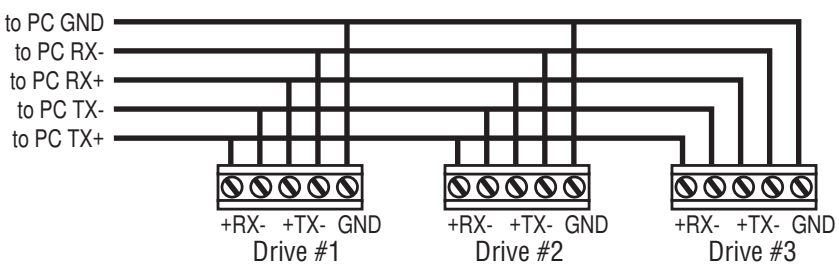
RS-485 allows you to connect more than one drive to a single host PC, PLC, HMI or other computer. It also allows the communication cable to be long (more than 1000 feet). But the device to which you connect must have an RS-485 port.

Pin diagram is shown to the right. Wiring diagrams can be found on the next page. We recommend the use of Category 5 cable. It is widely used for computer networks, it is inexpensive, easy to get and certified for quality and data integrity.

The ST drives can be used with either two wire or four wire RS-485 implementations. The connection can be point to point (i.e. one drive and one host) or a multi-drop network (one host and up to 32 drives).

Four Wire Systems utilize separate transmit and receive wires. One pair of wires must connect the host computer's transmit signals to each drive's RX+ and RX- terminals. Another pair connects the TX+ and TX- drive terminals to the host computer's receive signals. A logic ground terminal is provided on each drive and can be used to keep all drives at the same ground potential. This terminal connects internally to the DC power supply return (V-), so if all the drives on the RS-485 network are powered from the same supply it is not necessary to connect the logic grounds. *You should still connect one drive's GND terminal to the host computer ground.*

Four wire systems are better than two wire types because the host can send and receive data at the same time, increasing system throughput. Furthermore, the host never needs to disable its transmitter, which simplifies your software.

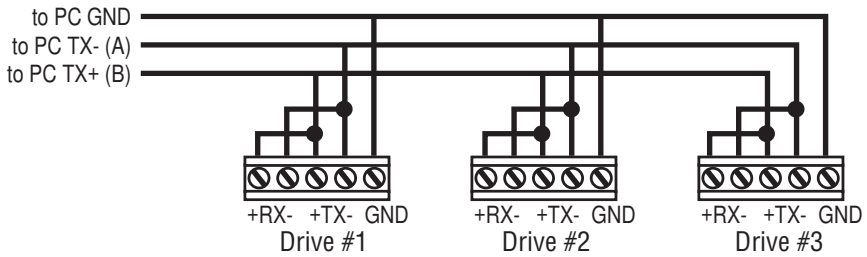


RS-485 Four Wire System

Two Wire Systems transmit and receive on the same pair of wires, which can lead to trouble. The host must not only disable its transmitter before it can receive data, it must do so quickly, before a drive begins to answer a query. The ST drives include a "transmit delay" parameter that can be adjusted to compensate for a host that is slow to disable its transmitter. This adjustment can be made over the network using the TD command, or it can be set using the *ST Configurator* software. It is not necessary to set the transmit delay in a four wire system.

RS-232 to RS-485 2-wire Converter

Model 485-25E from Integrity Instruments (800-450-2001) works well for converting your PC's RS-232 port to RS-485. It comes with everything you need. *Connect the adaptor's "B" pin to the ST drive's TX+ and RX+ terminals. Connect "A" to the drive's TX- and RX- terminals.*



RS-485 Two Wire System

Converting USB to RS-485

The USB-COMi-M from www.byterunner.com is an excellent choice for USB to RS-485 conversion. *Set SW1 to ON and SW2-4 to OFF. On the USB-COMi-M screw terminal connector: pin1 goes to RX- and TX-. Connect pin 2 to RX+ and TX+. Pin 6 is ground. The DB-9 is not used.*

Assigning Multi-Drop Addresses

Before wiring all of the drives in a multi-drop network, you'll need to connect each drive individually to the host computer so that a unique address can be assigned to each drive. Use the programming cable and the *ST Configurator™* software that came with your drive for this purpose.

Connect the drive to your PC, then launch the *ST Configurator™* software. Finally, apply power to your drive. If you have already configured your drive, then you should click the Upload button so that the *ST Configurator™* settings match those of your drive. Click on the Motion button, then select the "SCL" operating mode. If you have a Q drive, you may want to select "Q Programming". Either way, you'll see the

RS-485 Address panel appear. Just click on the address character of your choice. You can use the numerals 0..9 or the special characters ! " # $ % & ' ( ) * + , - . / : ; < = > ? @ . Just make sure that each drive on your network has a unique address. If you are using a 2 wire network, you may need to set the Transmit Delay, too. 10 milliseconds works on the adapters we've tried. Once you've made your choices, click Download to save the settings to your drive.

Assigning CANopen Addresses

Each node on a CANopen system must have a unique Node ID. Valid ranges for the Node ID are 0x01 through 0x7F. Node ID 0x00 is reserved in accordance with DS301. The Node ID is selected using two rotary switches; one sixteen position switch and one eight position switch. The sixteen position switch is located just to the left of the CANopen connector. The eight position switch is located inside the drive, and may only be accessed by removing the cover of the drive. It is recommended that the internal switch be left at the factory default setting "0". However, if additional Node IDs are required, it is possible to access them using the internal switch.

The Node ID is a concatenation of the two switch values. To set the Node ID to 0x3B, for example, turn the internal eight position switch to the value "3", and the sixteen position switch to the value "B".

Please refer to the CANopen manual for more information.

Connecting the Power Supply

If you need information about choosing a power supply, please read *Choosing a Power Supply* located elsewhere in this manual.

Connect the motor power supply "+" terminal to the driver terminal labeled "V+". Connect power supply "-" to the drive terminal labeled "V–". Use 18 or 20 gauge wire. The ST drives contain an internal fuse that connects to the power supply + terminal. This fuse is not user replaceable. If you want to install a user servicable fuse in your system install a fast acting fuse in line with the + power supply lead. Use a 4 amp fuse for the ST5 drives and 7 amps for the ST10.

The green ground screw on the corner of the chassis should be connected to earth ground.

Be careful not to reverse the wires. Reverse connection will destroy your driver, void your warranty and generally wreck your day.

If you plan to use a regulated power supply you may encounter a problem with regeneration. If you rapidly decelerate a load from a high speed, much of the kinetic energy of that load is transferred back to the power supply. This can trip the overvoltage protection of a switching power supply, causing it to shut down. We offer the RC050 "regeneration clamp" to solve this problem. If in doubt, buy an RC050 for your first installation. If the "regen" LED on the RC050 never flashes, you don't need the clamp.

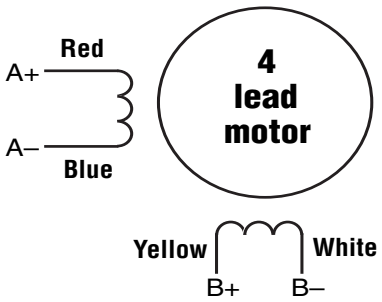
RC050 Regen Clamp

Connecting the Motor

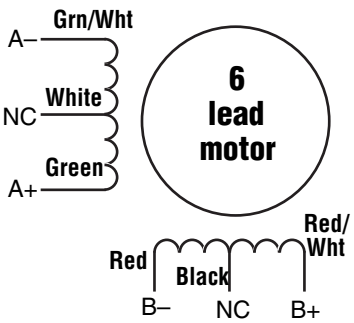
Never connect or disconnect the motor while the power is on.

Four lead motors can only be connected one way. Please follow the sketch at the right.

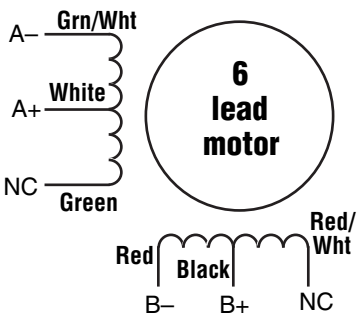
Six lead motors can be connected in series or center tap. In series mode, motors produce more torque at low speeds, but cannot run as fast as in the center tap configuration. In series operation, the motor should be operated at 30% less than the rated current to prevent overheating. Winding diagrams for both connection methods are shown below. NC means not connected.



4 Leads

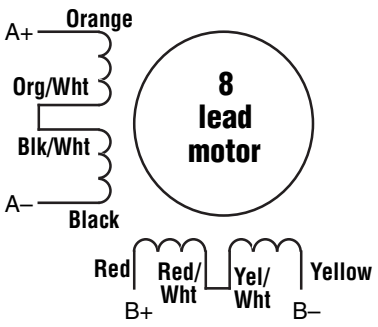


6 Leads Series Connected

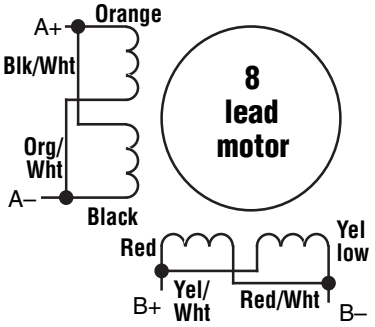


6 Leads Center Tap Connected

Eight lead motors can also be connected in two ways: series and parallel. As with six lead motors, series operation gives you less torque at high speeds, but may result in lower motor losses and less heating. In series operation, the motor should be operated at 30% less than the unipolar rated current. The motors recommended in this manual should be connected in parallel. The wiring diagrams for eight lead motors are shown on following page.



8 Leads Series Connected

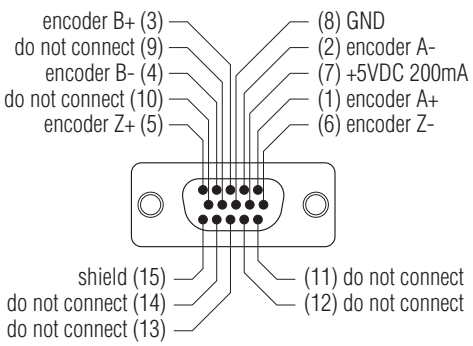


8 Leads Parallel Connected

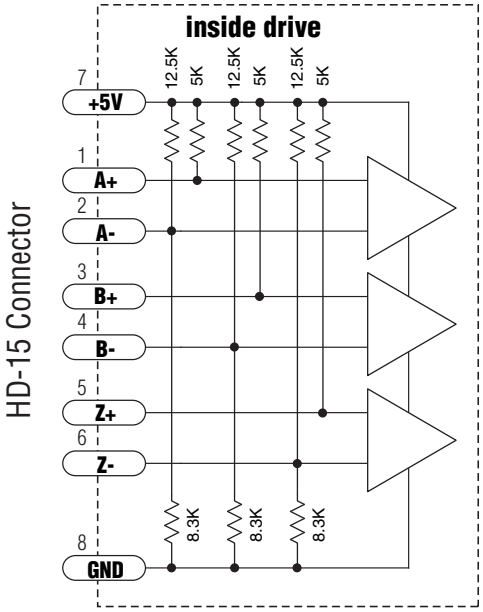
Connecting an Encoder (Requires the optional Encoder Feedback Card)

The encoder connections use a HD-15 connector, which you must connect to your encoder as shown below. See back page for mating connector information.

If your encoder is single ended, connect the encoder outputs to the A+, B+ and Z+ inputs. Leave A-, B- and Z- unconnected. (Z is the encoder index signal and is optional.)



Pin Assignments (facing drive)



Internal Circuit

Connecting Input Signals

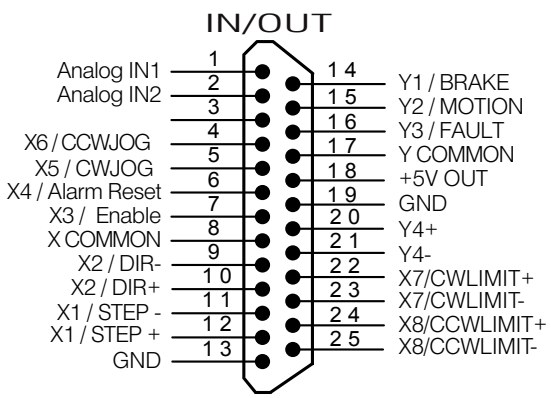
The ST drives have three types of inputs:

- high speed digital inputs for step & direction commands or encoder following, 5 volt logic
- digital inputs for other signals, 12 - 24 volt logic
- analog inputs for analog speed and positioning modes

All drives include eight digital inputs and two analog inputs.

- CW & CCW Limit: can be used to inhibit motion in a given direction, forcing the motor and load to travel within mechanical limits. Can be configured for active closed, active open or not used.
- IN1/STEP & IN2/DIR: digital signals for commanding position. Quadrature signals from encoders can also be used. These inputs can also be connected to sensors, switches and other devices for use with Q and Si™ commands such as *Wait Input, Seek Home, Feed to Sensor, If Input* and others.
- IN3,4,5,6: software programmable inputs can be used for motor enable, alarm reset or jogging. These inputs can also be connected to sensors, switches and other devices for use with Q and Si™ *Wait Input, Seek Home, Feed to Sensor, If Input* and other commands.
- Analog In: analog velocity or position command signal. Can be configured for 0-10V, 0-5V, ±10V or ±5V, with or without offset.

Connector Pin Diagram

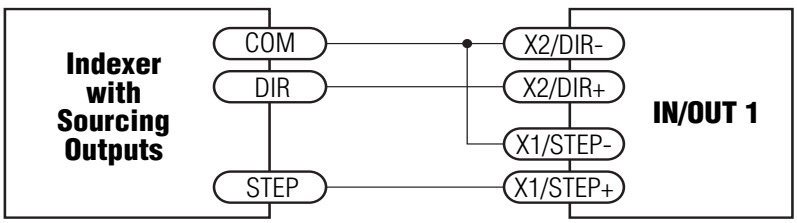


IN/OUT1 (DB-25) Connector

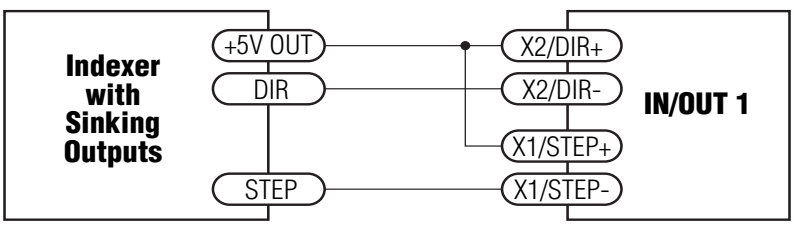
High Speed Digital Inputs

The ST Series drives include two high speed inputs called STEP and DIR. They accept 5 volt single-ended or differential signals, up to 2 MHz. Normally these inputs connect to an external controller that provides step & direction command signals. You can also connect a master encoder to the high speed inputs for following applications. Or you can use these inputs with *Wait Input, If Input, Feed to Sensor, Seek Home* and other such commands.

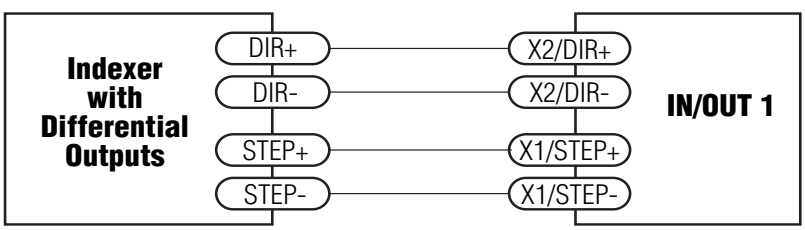
Connection diagrams follow.



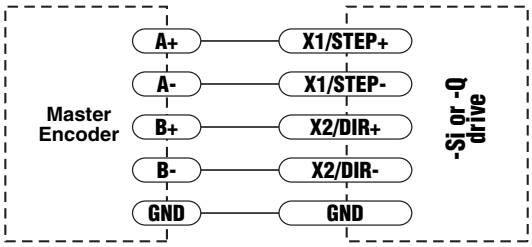
Connecting to indexer with Sourcing Outputs



Connecting to Indexer with Sinking Outputs



Connecting to Indexer with Differential Outputs
(Many High Speed Indexers have Differential Outputs)



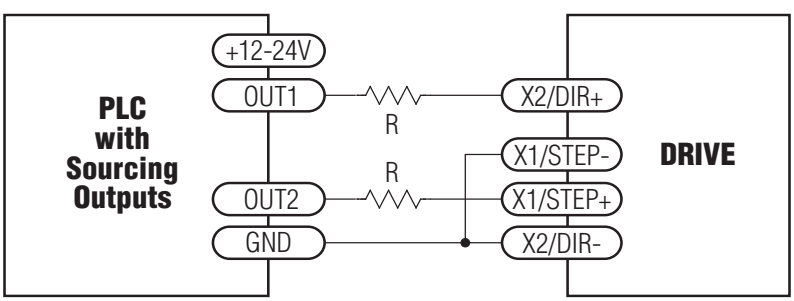
Wiring for Encoder Following

Using High Speed Inputs with 12-24 Volt Signals

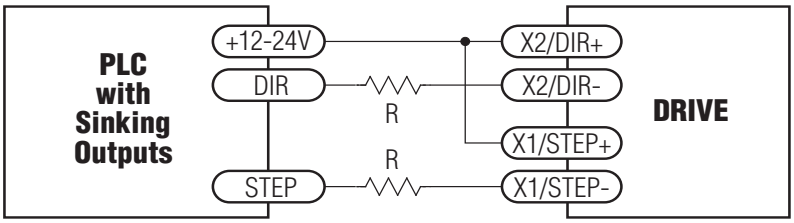
Most PLCs don't use 5 volt logic. You can connect signal levels as high as 24 volts to the STEP and DIR inputs if you add external dropping resistors, as shown below.

- For 12 volt logic, add 820 ohm, 1/4 watt resistors
- For 24 volt logic, use 2200 ohm, 1/4 watt resistors

The maximum voltage that can be applied to an input terminal is 24 volts DC. Never apply AC voltage to an input terminal.

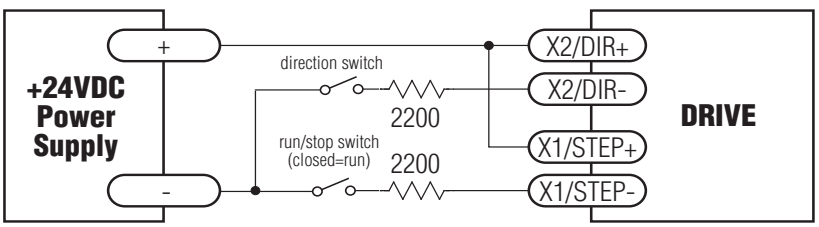


Connecting to PLC with Sourcing (PNP) Outputs
(Most PLC's use 24 volt logic)



Connecting to PLC with Sinking (NPN) Outputs

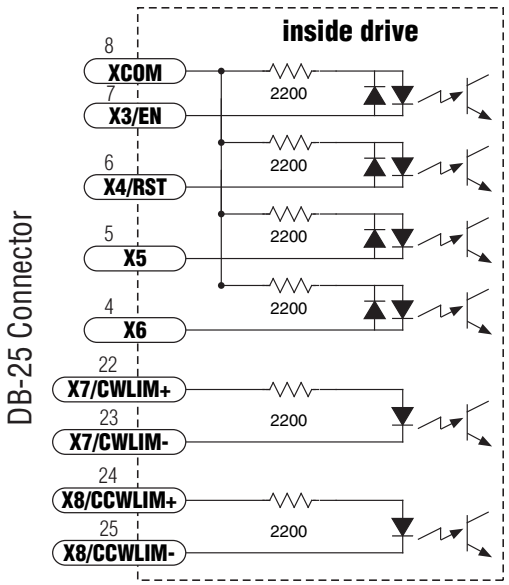
(Most PLC's use 24 volt logic)



Using Mechanical Switches at 24 Volts

Other Digital Inputs

As we mentioned in the previous section, the high speed STEP and DIR inputs are configured for five volt logic. All other digital inputs are designed for operation between 12 and 24 volts DC.



Single Ended Inputs

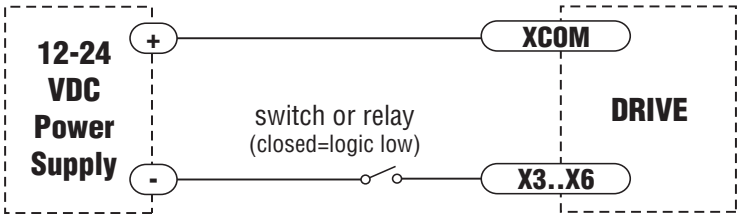
The ST drives include four single ended, optically isolated input circuits that can be used with sourcing or sinking signals, 12 to 24 volts. This allows connection to PLCs, sensors, relays and mechanical switches. Because the input circuits are isolated, they require a source of power. If you are connecting to a PLC, you should be able to get power from the PLC power supply. If you are using relays or mechanical switches, you will need a 12-24 V power supply. This also applies if you are connecting the inputs to the programmable outputs of an Si product from Applied Motion.

What is COM?

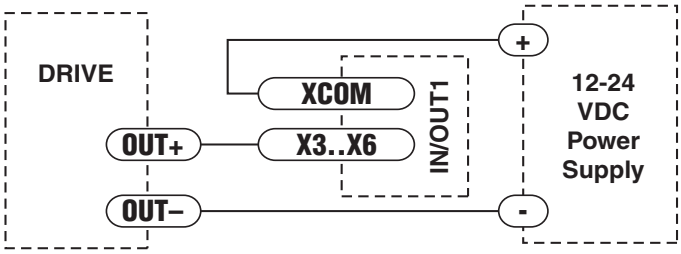
"Common" is an electronics term for an electrical connection to a common voltage. Sometimes "common" means the same thing as "ground", but not always. In the case of the ST drives, if you are using sourcing (PNP) input signals, then you will want to connect COM to ground (power supply -). If you are using sinking (NPN) signals, then COM must connect to power supply +.

Note: If current is flowing into or out of an input, the logic state of that input is low or closed. If no current is flowing, or the input is not connected, the logic state is high or open.

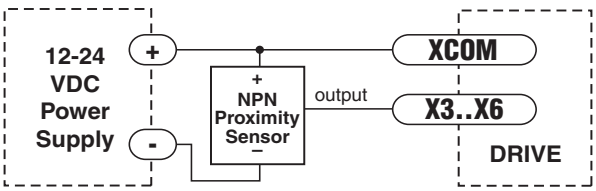
The diagrams on the following pages show how to connect the inputs to various commonly used devices.



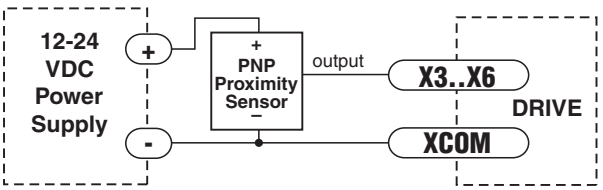
Connecting an Input to a Switch or Relay



Connecting another Si™ drive to the ST
(When output closes, input goes low).



Connecting an NPN Type Proximity Sensor to an input
(When prox sensor activates, input goes low).

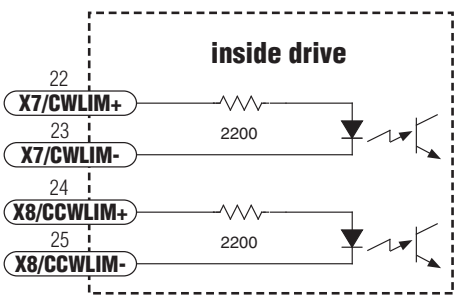


Connecting a PNP Type Proximity Sensor to a an input
(When prox sensor activates, input goes low).

Connecting Limit Switches

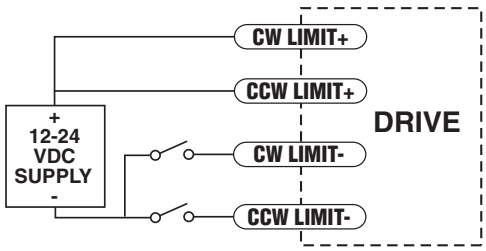
The CWLIMIT and CCWLIMIT inputs are used for connecting end of travel sensors. These inputs are differential, which allows you to use signals that are sinking (NPN), sourcing (PNP) or differential (line driver). By connecting switches or sensors that are triggered by the motion of the motor or load, you can force the motor to operate within certain limits. This is useful if a program or operator error could cause damage to your system by traveling too far.

The limit inputs are optically isolated. This allows you to choose a voltage for your limit circuits of 12 to 24 volts DC. This also allows you to have long wires on limit sensors that may be far from the drive with less risk of introducing noise to the drive electronics. The schematic diagram of the limit switch input circuit is shown below.



Wiring a Mechanical Limit Switch

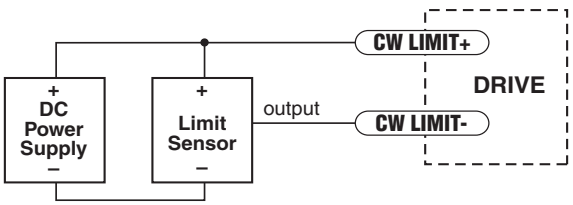
You can use normally open or normally closed limit switches. Either way, wire them as shown here. Be sure to set the polarity using the *Si Programmer™* for Si™ drives or the *ST Configurator™* software for the ST5-Q, ST10-Q, ST5-C and ST10-C.



Wiring a Limit Sensor

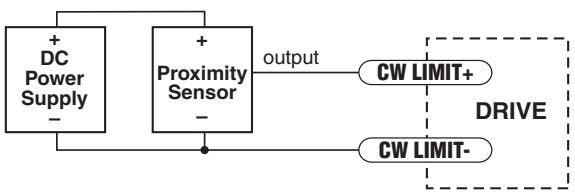
Some systems use active limit sensors that produce a voltage output rather than a switch or relay closure. These devices must be wired differently than switches.

If your sensor has an open collector output or a **sinking** output, wire it like this:



If the sensor output goes low at the limit, select the option “closed” (in the software). If the output is open, or high voltage, choose “open”.

Other sensors have **sourcing** outputs. That means that current can flow out of the sensor output, but not into it. In that case, wire the sensor this way:

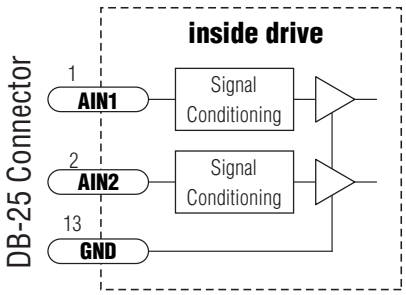


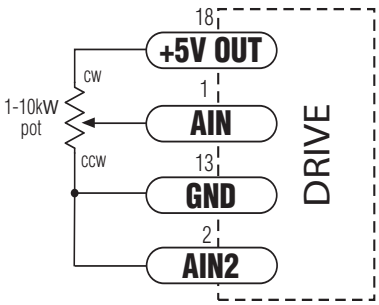
Analog Inputs

The ST drives feature two analog inputs. Each input can accept a signal range of 0 to 5 VDC, ±5 VDC, 0 to 10 VDC or ±10 VDC. The drive can be configured to operate at a speed or position that is proportional to the analog signal.

A shielded cable is recommended for electrically noisy environments.

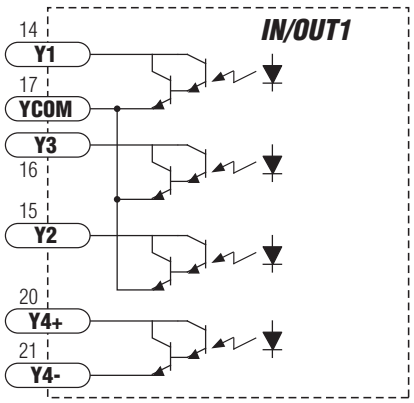
Use the *ST Configurator* software to set the signal range, offset, deadband and filter frequency.





Connecting a Potentiometer to Analog Input 1

Programmable Outputs

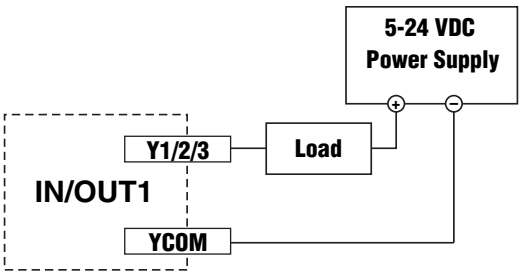


The ST drives feature four digital outputs. These outputs can be set to automically control a motor brake, to signal a fault condition, to indicate when the motor is moving or to provide an output frequency proportional to motor speed (tach signal). Or the outputs can be turned on and off by program instructions like Set Output.

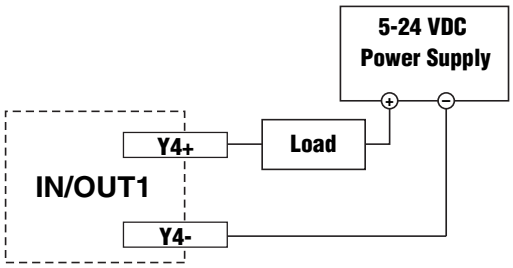
The outputs can be used to drive LEDs, relays and the inputs of other electronic devices like PLCs and counters. For Y4, the "+" (collector) and "-" (emitter) terminals of each transistor are available at the connector. This allows you to configure this output for current sourcing or sinking. The Y1-3 outputs can only sink current. The Y COM terminal must be tied to power supply (-).

Diagrams of each type of connection follow.

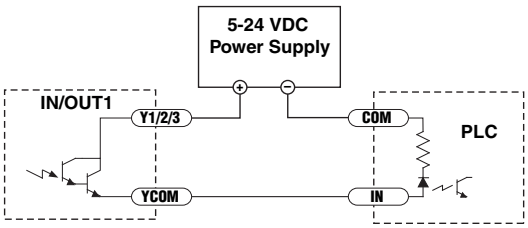
Do not connect the outputs to more than 30VDC.
The current through each output terminal must not exceed 100 mA.



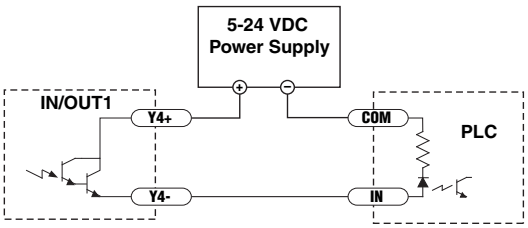
Sinking Output Using Y1, Y2, Y3



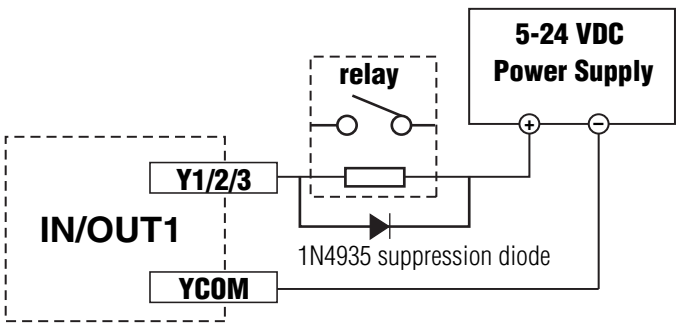
Sinking Output Using Y4



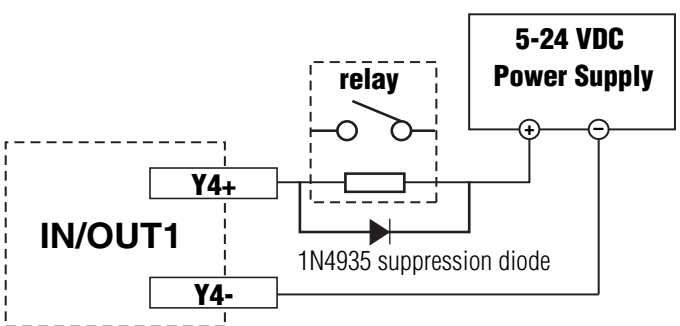
Sourcing Output
Y1, Y2 or Y3



Sourcing Output
Using Y4



Driving a Relay
Y1, Y2 or Y3



Driving a Relay
Using Y4

Choosing a Power Supply

When choosing a power supply, there are many things to consider. If you are manufacturing equipment that will be sold to others, you probably want a supply with all the safety agency approvals. If size and weight are an issue use a switching supply.

You must also decide what size of power supply (in terms of voltage and current) is needed for your application.

Voltage

PWM drives work by switching the voltage to the motor terminals on and off while monitoring current to achieve a precise level of phase current. To do this efficiently and silently, you'll want to have a power supply with a voltage rating at least five times that of the motor. Depending on how fast you want to run the motor, you may need even more voltage than that.
If you choose an unregulated power supply, make sure the no load voltage of the supply does not exceed the drive's maximum input voltage specification.

Current

The maximum supply current you could ever need is the sum of the two phase currents. However, you will generally need a lot less than that, depending on the motor type, voltage, speed and load conditions. That's because the ST drives use switching amplifiers, converting a high voltage and low current into lower voltage and higher current. The more the power supply voltage exceeds the motor voltage, the less current you'll need from the power supply. A motor running from a 48 volt supply can be expected to draw only half the supply current that it would with a 24 volt supply.

We recommend the following selection procedure:

1. If you plan to use only a few drives, get a power supply with at least twice the rated phase current of the motor.

2. If you are designing for mass production and must minimize cost, get one power supply with more than twice the rated current of the motor. Install the motor in the application and monitor the current coming out of the power supply and into the drive at various motor loads. This will tell you how much current you really need so you can design in a lower cost power supply.

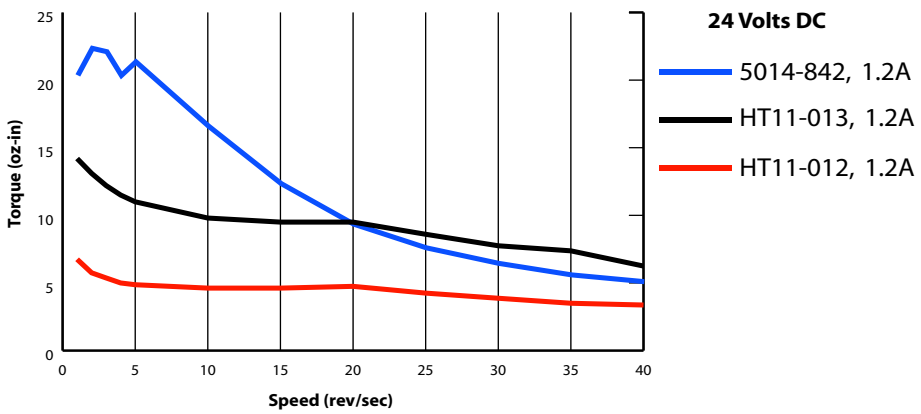
Recommended Motors

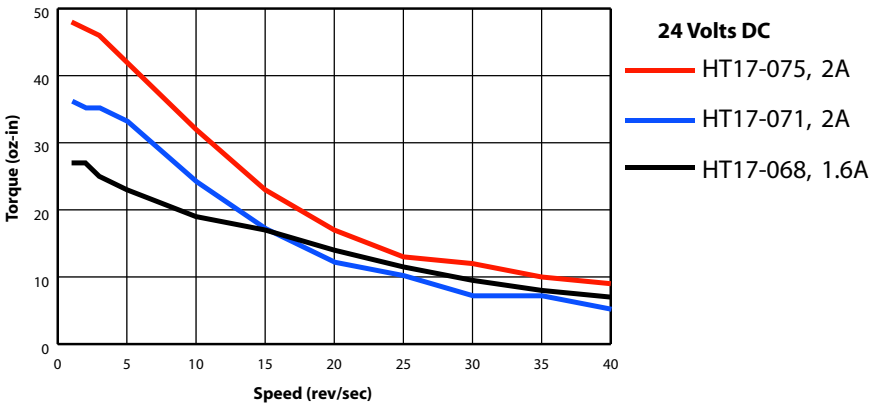
Part Number	Holding Torque oz-in	Holding Torque kg-cm	Drive Current Setting amps	Resistance ohms	Inductance mH	Rotor Inertia g-cm^2
HT11-012	7.0	0.50	1.2	1.4	1.4	8
HT11-013	15.0	1.08	1.2	2.0	2.6	18
5014-842	26.0	1.87	1.2	4.3	5.5	20
HT17-068	31.4	2.26	1.6	2.1	2.8	35
HT17-071	51.0	3.67	2.0	1.7	3.6	54
HT17-075	62.8	4.52	2.0	1.7	3.0	68
HT23-394	76.6	5.52	3.4	0.7	1.4	120
HT23-398	177	12.7	5.0	0.4	1.2	300
HT23-401	264	19.0	5.0	0.5	1.6	480
HT34-485	650	46.8	10.0	0.19	1.3	1400
HT34-486	1200	86.4	9.7	0.27	2.2	2680
HT34-487	1845	133	10.0	0.27	2.4	4000

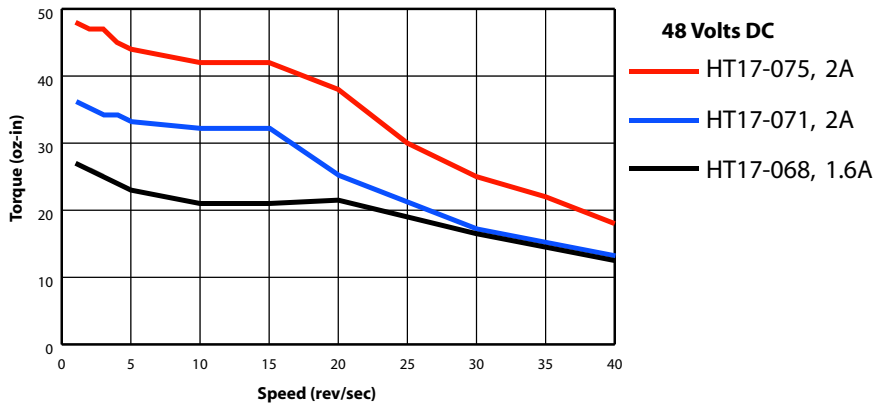
Note: The "Drive Current Setting" shown here differs from the rated current of each motor because the rated current is RMS and the drive current setting is peak sine. If you are using a motor not listed here, for best results set the drive current at the motor's rated current x 1.2.

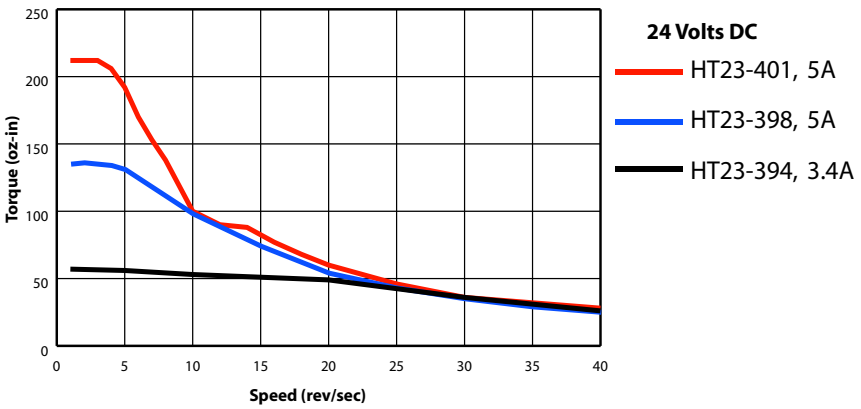
Torque-Speed Curves

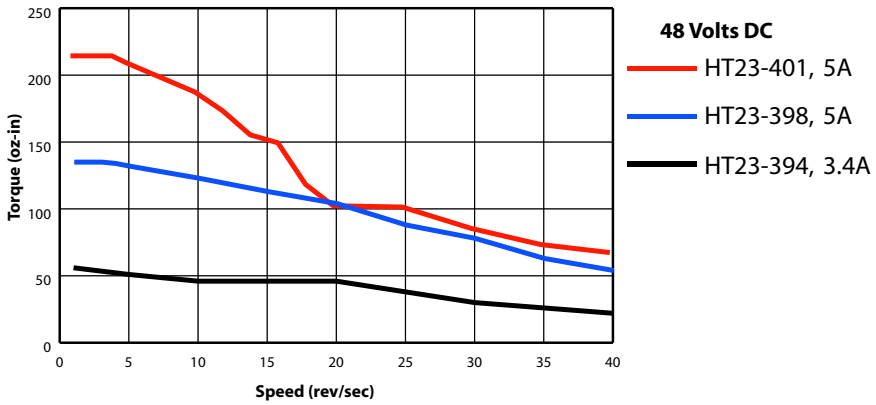
Note: all torque curves were measured at 20,000 steps/rev.

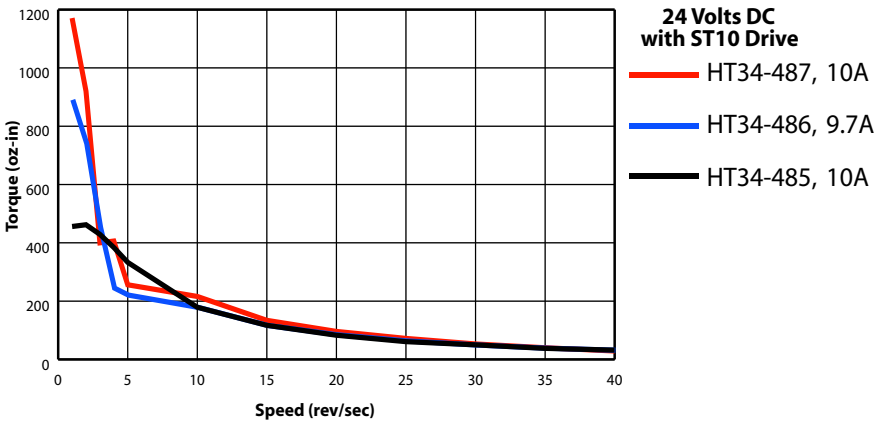


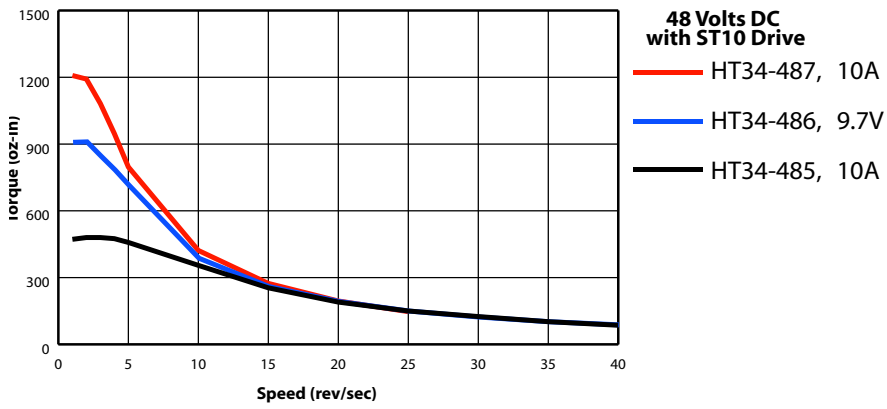

Torque (oz-in)
Speed (rev/sec)
0
10
20
30
40
50
0
5
10
15
20
25
30
35
40
24 Volts DC
HT17-075, 2A
HT17-071, 2A
HT17-068, 1.6A

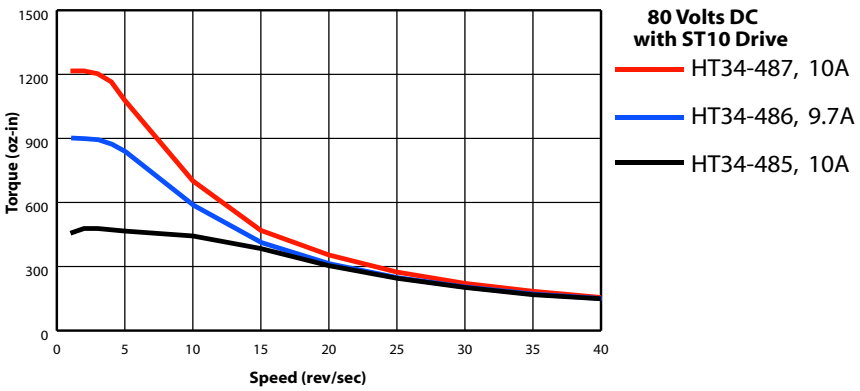

Torque (oz-in)
Speed (rev/sec)
0
10
20
30
40
50
0
5
10
15
20
25
30
35
40
48 Volts DC
HT17-075, 2A
HT17-071, 2A
HT17-068, 1.6A


Torque (oz-in)
Speed (rev/sec)
0
50
100
150
200
250
0
5
10
15
20
25
30
35
40
24 Volts DC
HT23-401, 5A
HT23-398, 5A
HT23-394, 3.4A


Torque (oz-in)
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
Speed (rev/sec)
48 Volts DC
HT23-401, 5A
HT23-398, 5A
HT23-394, 3.4A


Torque (oz-in)
1200
1000
800
600
400
200
0
0
5
10
15
20
25
30
35
40
Speed (rev/sec)
24 Volts DC
with ST10 Drive
HT34-487, 10A
HT34-486, 9.7A
HT34-485, 10A


Torque (oz-in)
1500
1200
900
600
300
0
0
5
10
15
20
25
30
35
40
Speed (rev/sec)
48 Volts DC
with ST10 Drive
HT34-487, 10A
HT34-486, 9.7V
HT34-485, 10A



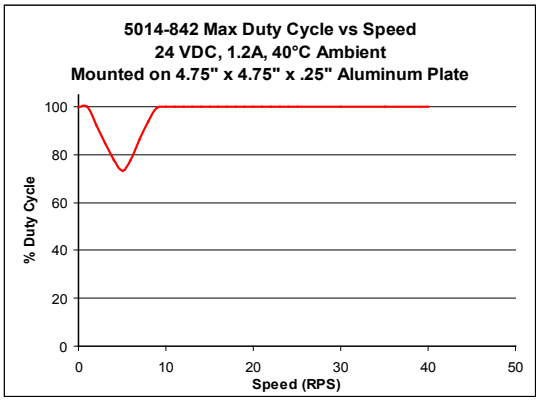
Motor Heating

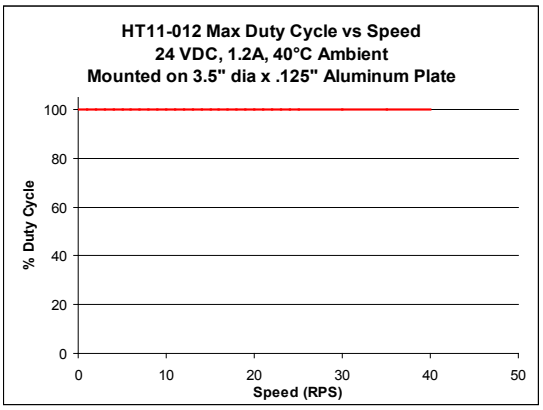
Step motors convert electrical power from the driver into mechanical power to move a load. Because step motors are not perfectly efficient, some of the electrical power turns into heat on its way through the motor. This heating is not so much dependent on the load being driven but rather the motor speed and power supply voltage. There are certain combinations of speed and voltage at which a motor cannot be continuously operated without damage.

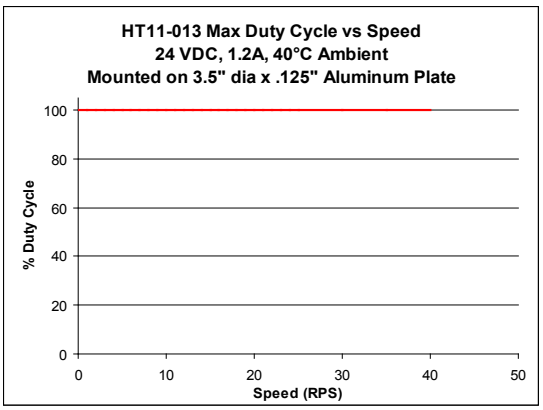
We have characterized the recommended motors in our lab and provided curves showing the maximum duty cycle versus speed for each motor at commonly used power supply voltages. Please refer to these curves when planning your application.

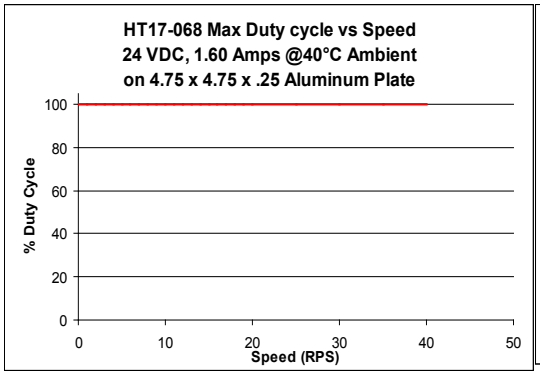
Please also keep in mind that a step motor typically reaches maximum temperature after 30 to 45 minutes of operation. If you run the motor for one minute then let it sit idle for one minute, that is a 50% duty cycle. Five minutes on and five minutes off is also 50% duty. However, one hour on and one hour off has the effect of 100% duty because during the first hour the motor will reach full (and possibly excessive) temperature.

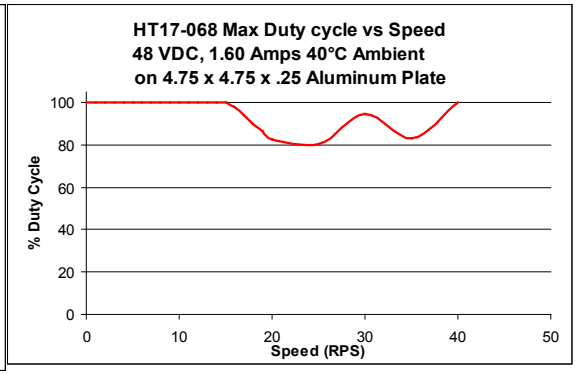
The actual temperature of the motor depends on how much heat is conducted, convected or radiated out of it. Our measurements were made in a 40°C (104°F) environment with the motor mounted to an aluminum plate sized to provide a surface area consistent with the motor power dissipation. Your results may vary.

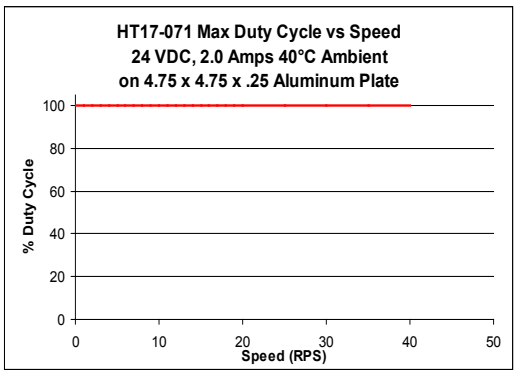

5014-842 Max Duty Cycle vs Speed
24 VDC, 1.2A, 40°C Ambient
Mounted on 4.75" x 4.75" x .25" Aluminum Plate
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

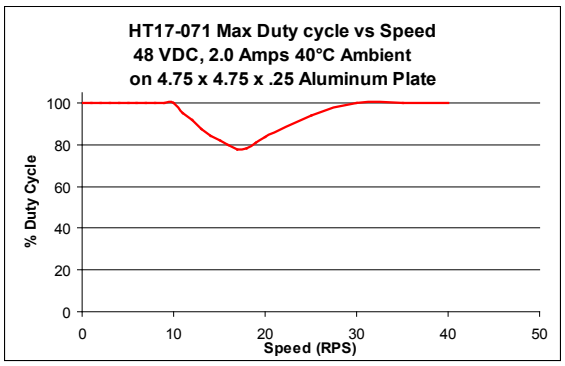

HT11-012 Max Duty Cycle vs Speed
24 VDC, 1.2A, 40°C Ambient
Mounted on 3.5" dia x .125" Aluminum Plate
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

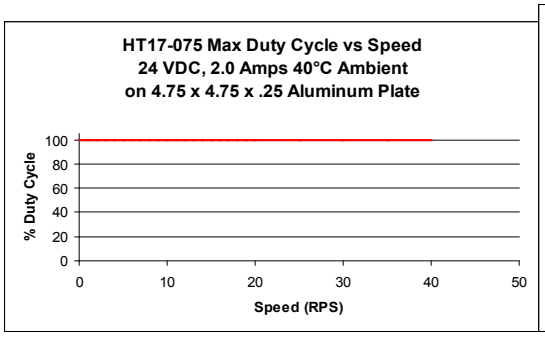

HT11-013 Max Duty Cycle vs Speed
24 VDC, 1.2A, 40°C Ambient
Mounted on 3.5" dia x .125" Aluminum Plate
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

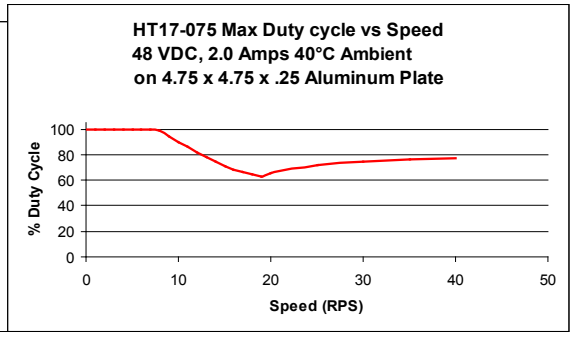

HT17-068 Max Duty cycle vs Speed
24 VDC, 1.60 Amps @40°C Ambient
on 4.75 x 4.75 x .25 Aluminum Plate
% Duty Cycle
Speed (RPS)

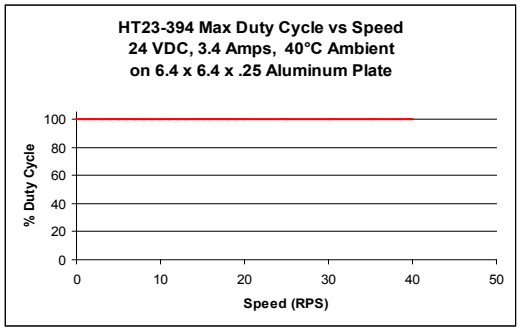

HT17-068 Max Duty cycle vs Speed
48 VDC, 1.60 Amps 40°C Ambient
on 4.75 x 4.75 x .25 Aluminum Plate
% Duty Cycle
Speed (RPS)

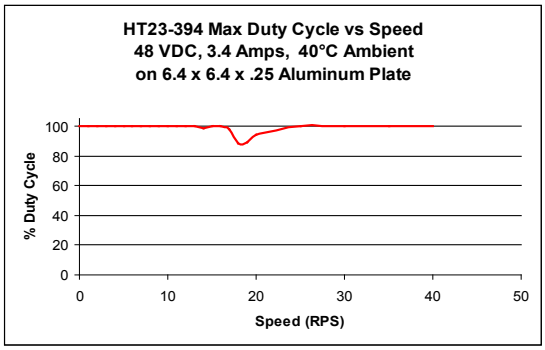

HT17-071 Max Duty Cycle vs Speed
24 VDC, 2.0 Amps 40°C Ambient
on 4.75 x 4.75 x .25 Aluminum Plate
% Duty Cycle
Speed (RPS)

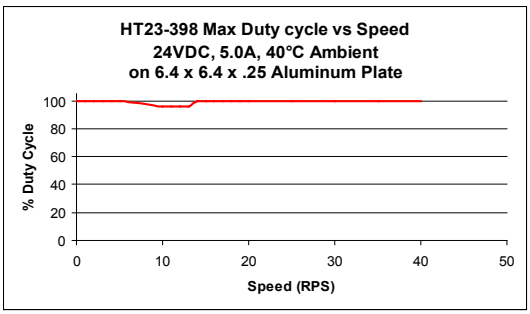

HT17-071 Max Duty cycle vs Speed
48 VDC, 2.0 Amps 40°C Ambient
on 4.75 x 4.75 x .25 Aluminum Plate
% Duty Cycle
Speed (RPS)

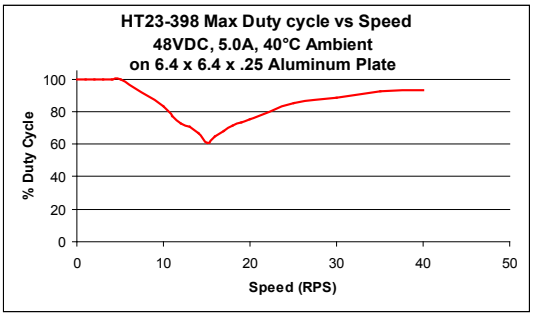

HT17-075 Max Duty Cycle vs Speed
24 VDC, 2.0 Amps 40°C Ambient
on 4.75 x 4.75 x .25 Aluminum Plate
% Duty Cycle
Speed (RPS)

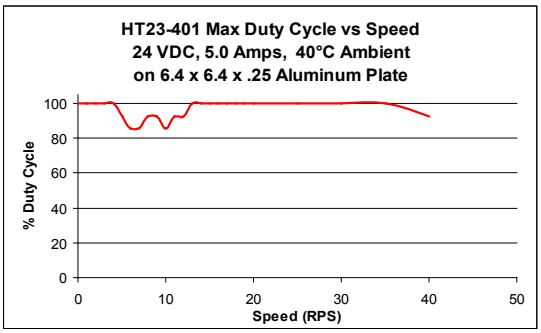

HT17-075 Max Duty cycle vs Speed
48 VDC, 2.0 Amps 40°C Ambient
on 4.75 x 4.75 x .25 Aluminum Plate
% Duty Cycle
Speed (RPS)

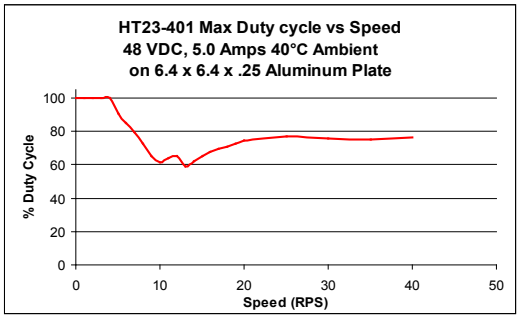

HT23-394 Max Duty Cycle vs Speed
24 VDC, 3.4 Amps, 40°C Ambient
on 6.4 x 6.4 x .25 Aluminum Plate
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

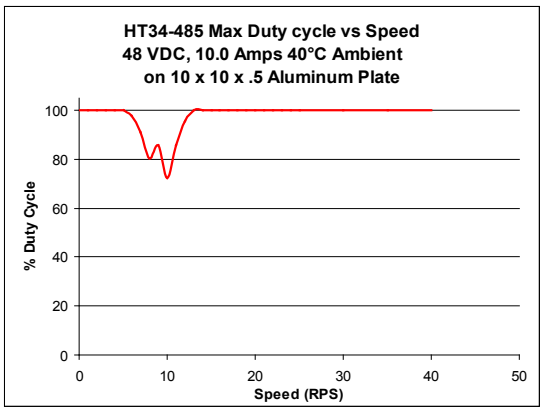

HT23-394 Max Duty Cycle vs Speed
48 VDC, 3.4 Amps, 40°C Ambient
on 6.4 x 6.4 x .25 Aluminum Plate
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

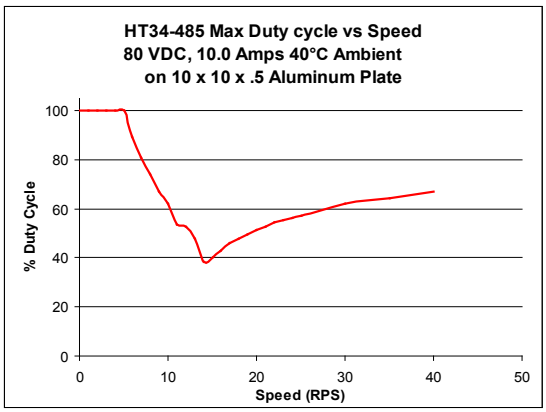

HT23-398 Max Duty cycle vs Speed
24VDC, 5.0A, 40°C Ambient
on 6.4 x 6.4 x .25 Aluminum Plate
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

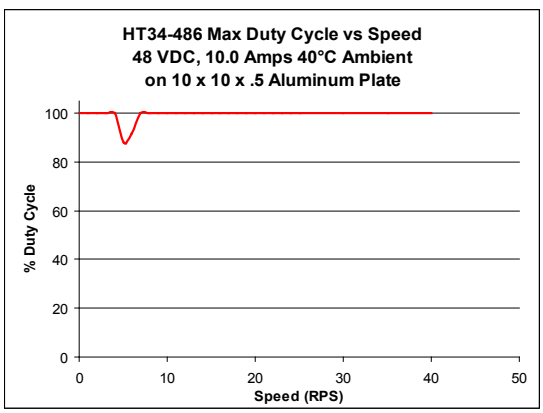

HT23-398 Max Duty cycle vs Speed
48VDC, 5.0A, 40°C Ambient
on 6.4 x 6.4 x .25 Aluminum Plate
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

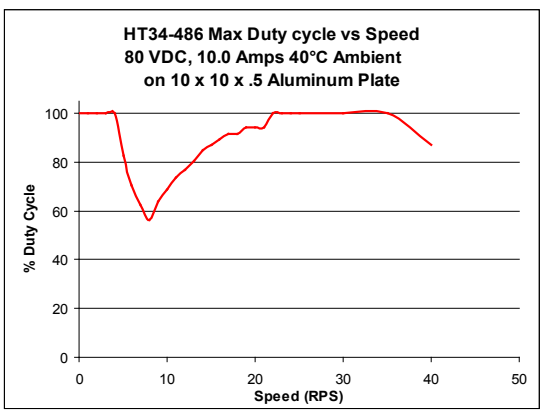

HT23-401 Max Duty Cycle vs Speed
24 VDC, 5.0 Amps, 40°C Ambient
on 6.4 x 6.4 x .25 Aluminum Plate
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

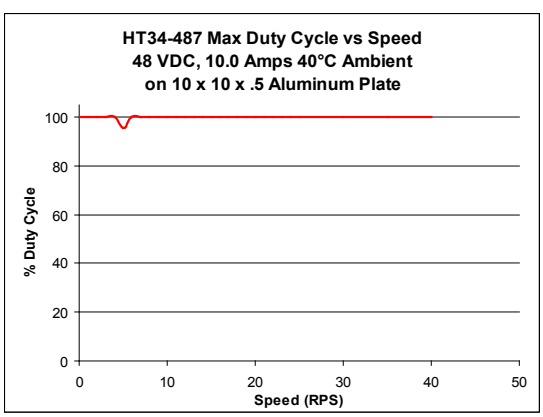

HT23-401 Max Duty cycle vs Speed
48 VDC, 5.0 Amps 40°C Ambient
on 6.4 x 6.4 x .25 Aluminum Plate
% Duty Cycle
100
80
60
40
20
0
0
10
20
30
40
50
Speed (RPS)

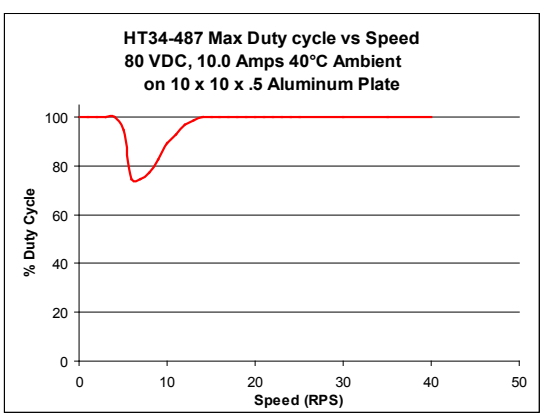

HT34-485 Max Duty cycle vs Speed
48 VDC, 10.0 Amps 40°C Ambient
on 10 x 10 x .5 Aluminum Plate
% Duty Cycle
Speed (RPS)


HT34-485 Max Duty cycle vs Speed
80 VDC, 10.0 Amps 40°C Ambient
on 10 x 10 x .5 Aluminum Plate
% Duty Cycle
Speed (RPS)


HT34-486 Max Duty Cycle vs Speed
48 VDC, 10.0 Amps 40°C Ambient
on 10 x 10 x .5 Aluminum Plate
% Duty Cycle
Speed (RPS)


HT34-486 Max Duty cycle vs Speed
80 VDC, 10.0 Amps 40°C Ambient
on 10 x 10 x .5 Aluminum Plate
% Duty Cycle
Speed (RPS)


HT34-487 Max Duty Cycle vs Speed
48 VDC, 10.0 Amps 40°C Ambient
on 10 x 10 x .5 Aluminum Plate
% Duty Cycle
Speed (RPS)

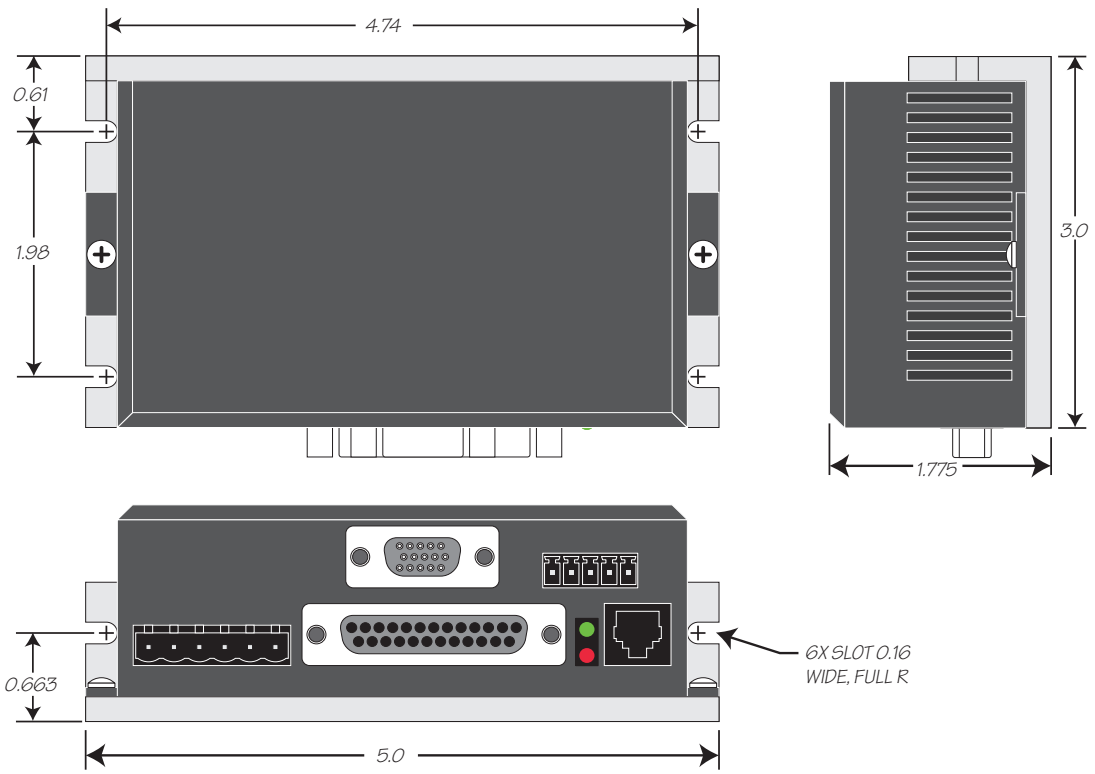

HT34-487 Max Duty cycle vs Speed
80 VDC, 10.0 Amps 40°C Ambient
on 10 x 10 x .5 Aluminum Plate
% Duty Cycle
Speed (RPS)

Mounting the Drive

You can mount your drive on the wide or the narrow side of the chassis using #6 screws. If possible, the drive should be securely fastened to a smooth, flat metal surface that will help conduct heat away from the chassis. If this is not possible, then forced airflow from a fan may be required to prevent the drive from overheating.

- ***Never use your drive in a space where there is no air flow or where other devices cause the surrounding air to be more than 40°C.***
- ***Never put the drive where it can get wet or where metal or other electrically conductive particles can get on the circuitry.***
- ***Always provide air flow around the drive. When mouting multiple ST drives near each other, maintain at least one half inch of space between drives.***

Mechanical Outline



Technical Specifications

Amplifier
Digital MOSFET. 20 kHz PWM.
ST5: 18 - 53 VDC, motor current: 0.5 to 5.0 amps/phase peak of sine
ST10: 18 - 88 VDC, motor current: 0.5 to 10 amps/phase peak of sine

Digital Inputs
Step & Direction: differential, optically isolated, 5V logic. 330 ohms internal resistance.
0.5 µsec minimum pulse width. 2 µsec minimum set up time for direction signal.
All other digital inputs: optically isolated, 12 - 24V logic. 2200 ohms. Maximum current: 10 mA.

Analog Inputs
±10VDC, 12 bit ADC, 100k ohms internal impedance.

Outputs
Photodarlington, 100 mA, 30 VDC max. Voltage drop: 1.2V max at 100 mA.

Physical
1.775 x 3 x 5 inches overall. 10 oz (280 g)
Ambient temperature range: 0°C to 40°C.

Mating Connectors and Accessories

Mating Connectors

Motor/power supply: PCD P/N ELV06100, included with drive.
IN/OUT1: DB-25 male. AMP P/N 5-747912-2. Shell Kit AMP P/N 5-748678-3. Included.
Optional encoder feedback: HD-15 male. Norcomp P/N 180-015-102-001. Shell Kit AMP P/N 5-748678-1. Not included.

Accessories

Breakout Box for DB-25 Connector
BOB-1, includes cable

Screw Terminal Connectors that mate directly to the DB-25 connector on the front panel of the drive:
Phoenix Contact P/N 2761622
This connector is not available from Applied Motion. You must purchase it from a Phoenix distributor.

Mating Cable for IN/OUT connector with "flying leads"
Black Box P/N: BC00702
This cable is not available from Applied Motion. You must purchase it from Black Box.
Useful for custom wired applications. This shielded cable has a DB-25 connector on each end. You can cut off the female end to create a 6 foot "DB-25 to flying lead cable".
It'll be easier to wire if you get the cable color chart from Black Box's web site.

Regeneration Clamp:
Applied Motion Products RC050.

Power supplies:
Applied Motion Products PS320A48 (48 VDC, 6.7A)
Applied Motion Products PS150A24 (24 VDC, 6.3A)
Applied Motion Products PS50A24 (24 VDC, 2.1A)

Operator Terminal (-Si drives only)
Applied Motion Products MMI-01 or MMI-02 (backlit).

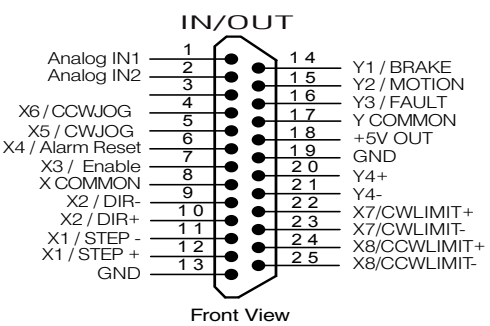
Recommended CANopen USB Adapter (-C drives only)
Kvaser LeafLight HS *This adapter is not available from Applied Motion Products*

Alarm Codes

In the event of an error, the red and green LEDs on the main board will flash in alternating red-green patterns as shown below. The pattern repeats until the alarm is cleared.

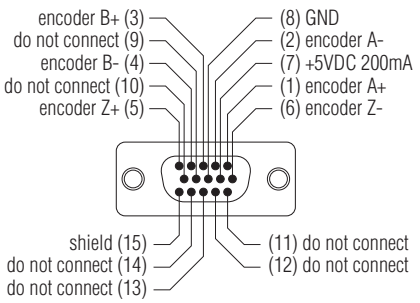
Code	Error
solid green	no alarm, motor disabled
flashing green	no alarm, motor enabled
1 red, 1 green	motor stall (optional encoder only)
1 red, 2 green	move attempted while drive disabled
1 red, 3 green	subroutine stack overflow (Si only)
2 red, 1 green	ccw limit
2 red, 2 green	cw limit
2 red, 3 green	subroutine stack underflow (Si only)
3 red, 1 green	drive overheating
3 red, 2 green	internal voltage out of range
3 red, 3 green	blank Q segment
4 red, 1 green	power supply overvoltage
4 red, 2 green	power supply undervoltage
4 red, 3 green	bad instruction in Si program
5 red, 1 green	over current / short circuit
5 red, 2 green	motor resistance out of range
6 red, 1 green	open motor winding
6 red, 2 green	bad encoder signal (optional encoder only)
7 red, 1 green	serial communication error
7 red, 2 green	flash memory error
8 red, 1 green	internal voltage out of range

Connector Diagrams



Front View

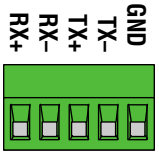
DB-25 I/O Connector



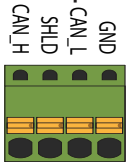
Front View

HD-15 Encoder Connector

RS-485/422



CANopen



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